4.17 Herbicides

4.17.1 Introduction

We propose to use a subclass of pesticides referred to as "herbicides." Herbicides are used in forestry to control brush and grasses and are primarily used for maintenance of areas that have been previously cleared of heavy vegetative fuels. The periodic application of herbicides inhibits or slows the regrowth of vegetation. The initial application of herbicides is commonly done shortly after the removal of heavy fuel because the cutting and/or burning of many plant species accelerates vegetative regrowth and/or facilitates germination of seed stored in the soil. In some instances it is beneficial to perform a treatment on certain species before cutting in order to avoid the rapid re-sprouting and increased amounts of herbicides. In addition, on timberlands herbicides are commonly used for site preparation, conifer release, and weed control (Shepard et al., 2004). This section describes the types and uses of the most commonly used herbicides in forest and range lands, and the potential effects on these environments.

With the exception of the no-herbicide alternative, California Department of Forestry & Fire Protection (CAL FIRE) anticipates the possible use of herbicides, including any associated additives or surfactants, and one fungicide as part of the Vegetation Treatment Program (VTP). See Section 5.17 for a listing of specific herbicides that are proposed for use with VTP projects. Table 14.17.9 provides a list of known adjuvant (e.g. additions to the herbicide) ingredients that are common in commercial herbicide formulations, or are commonly added to formulations just prior to application in forest and rangeland settings. This list represents adjuvants that have been known to be used in forestry applications in California. The list is not intended to be exhaustive, particularly given that the U.S. EPA encourages chemical companies to release inert ingredients information on product labels, but manufacturers are not required to do so for proprietary reasons. New products are regularly being developed with formulations and application techniques that provide for better control and improved environmental toxicology profiles. For these reasons, in the future, there may be additions or deletions to the list of herbicides considered for use as part of the VTP.

Information on herbicide use and cautions are available on the herbicide product's specific label and Material Safety Data Sheet (MSDS). The California Environmental Protection Agency (CAL EPA), Department of Pesticide Regulation (CDPR), maintains a searchable database of pesticide product information (www.cdpr.ca.gov/docs/label/m4.htm), as does the National Pesticide Information Center (http://npic.orst.edu/) and the Extension Toxicology Network (EXTOXNET) (http://extoxnet.orst.edu/). The U.S. Forest Service has compiled information on herbicides used in wildlands (http://infoventures.com/e-hlth/pestcide/pest-fac.html) as well as technical risk assessments at http://www.fs.fed.us/foresthealth/pesticide/risk.shtml. Additional toxicology information may be acquired through database search engines, such as TOXLINE (produced by U.S. National Library of Medicine) or PubMed.

Potential for Environmental Exposure

The application of herbicides will occur predominately on private forest and range land, and potentially on some public lands (i.e. state forests and parks), with similar treatments by federal agencies on public lands. While public exposure is likely to be limited there may be risk to nearby residents and other members of the public such as forest visitors and recreational users that may be exposed through accidental overspray or herbicide drift. It is not anticipated that aerial application will be used under the VTP, but if it is applied it could be of concern on immediately adjoining public use or residential lands. Where herbicide runs off or enters the groundwater, it has the potential to contaminate public water supplies and affect populations remote from the site of application. Groundwater contamination from pesticides has been a problem in many agricultural areas. Finally, for persistent or bioaccumulative herbicides, the public could be exposed to residual contamination through consuming meat of herbivores or fish exposed to herbicides directly or through diet. Additionally, humans could potentially be exposed to herbicides by consuming or handling vegetation.

The environment that is potentially affected by herbicide applications are the forests and range lands of California as described in Chapter 1 of the PEIR. This area includes a broad range of landscapes and is characterized by diverse plant and wildlife species, as well as a wide variety of habitat types (see Biological Resource section for a detailed discussion).

4.17.2 Regulatory Framework

In California, both national and state agencies regulate the use of pesticides. The national law that is the regulatory framework regarding the efficiency, registration, sale and use of all pesticides, including herbicides, is the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The U.S. Environmental Protection Agency (EPA) is the agency that nationally administers FIFRA regulations, with the objective of protecting human health and the environment. FIFRA does not fully preempt state law, so state and local agencies may also regulate the use of pesticides (http://www.epa.gov/agriculture/lfra.html). Thus, pesticides are regulated nationally by the U.S. EPA, and by state or local agencies, such as the California Department of Pesticide Regulation (CDPR) and county agricultural commissioners.

All new pesticides must be registered with the U.S. EPA, and when registered are very specific regarding uses, chemical quantity, the site types, and other information to be followed on the label. Most pesticides are usually registered on the basis of a single chemical ingredient, which has properties that control or eliminate particular target pest species (http://www.epa.gov/pesticides/fees/tool/resources/active_ingredient.htm). Such a chemical is referred to as an ‘active ingredient’ or a.i. When the chemical manufacturer applies for registration of an a.i., extensive human health, floral, faunal and environmental toxicity data will be supplied by manufacturers to the U.S. EPA as part of the application. Once manufacturers are granted a.i. registration, the U.S. EPA must be notified whenever there is new evidence reflecting potential adverse health or environmental effects (see 40 CR 158 for data requirements). Pesticides must be registered by both the U.S. EPA and the state of proposed use before the pesticide can be distributed (http://www.epa.gov/pesticides/regulating/index.htm).

There are other types of pesticide registration that deserve mentioning in addition to those that are used for new a.i.’s. (http://www.epa.gov/pesticides/bluebook/chapter2.html#newuse). Once registered, the initial product containing the registered a.i. can be altered by the registrant to create new formulations in several ways, such as changing ingredient concentrations, or adding new ‘inert’ ingredients. These *new chemical* formulations may be created to improve efficacy or effectiveness of the a.i. at eradicating targeted species, or aim to lessen impacts on non-target species and/or the environment compared to the original formulation. A *new use* may also be found for the initial product that is not on the label, and thus a new use registration application is required. The amount of new human, faunal, floral, and environmental toxicity data required to be submitted by registrants for a new product using a registered a.i. is dependent on similarities and differences in the new formulation.

California Department of Pesticide Regulation (CDPR)

The California Department of Pesticide Regulation (CDPR) regulates pesticide registration, sales and use to protect human health and the environment. CDPR provides further oversight that includes product evaluation, environmental monitoring, residue testing of fresh produce, and local use enforcement through County Agricultural Commissioner offices (CACs).

Before a pesticide can be possessed, sold, or used in California, the pesticide must be registered by CDPR. CDPR builds upon the existing EPA label and may add additional restriction, but cannot remove or diminish EPA requirements. Prior to registration, CDPR's staff reviews each pesticide to ensure that it meets stringent standards, as prescribed in the laws (Food and Agricultural Code) and regulations (California Code of Regulations) governing pesticides in California. The law requires manufacturers to submit tests and toxicological studies of pesticides to CDPR staff for evaluation. Reviews include, but are not limited to, the chemical properties of the product, intended use patterns, potential human health effects, and environmental fate of the product. Based on the evaluation CDPR will determine if the pesticide can be registered for use in California. The laws and regulations governing the possession, sale, and use of pesticides are enforced by CDPR in cooperation with the office of the county agricultural commissioner (CAC) within each county. CACs are the primary local enforcement agents for pesticide laws and regulations in California. See CDPR (2001; www.cdpr.ca.gov) for additional information on pesticide regulation in California.

Under state and federal law, only certain herbicide formulations are approved for use in forestry and range. In California, herbicide application involving restricted use pesticides for commercial use requires a permit and a written recommendation of a licensed pest control advisor (PCA) and must be done under the supervision of licensed Pest Control Operator. Non-restricted use pesticides only require a PCA recommendation. Herbicide use is inspected by and reported to the CAC. These measures are intended to ensure that the application of herbicides is done correctly according to federal and California state regulations.

In some cases individual products, such as multiple a.i.'s, specific carriers, and/or adjuvants are combined by herbicide handlers to provide a “tank mix” designed for a specific vegetation control problem. Herbicide mixtures that include surfactants or other adjuvants are not tested as part of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) evaluation process, and these types of unregulated chemical changes created in a tank mix may increase toxicity. Potentiation lowers pest tolerance to one or more of the mixture ingredients. Synergism occurs if the toxicity of the mixture is greater than the sum of its parts (see Section 4.17.4, *Prevalent Public Issues Relating to Herbicide Application*, Synergistic toxicity). Lastly, a coalescence effect occurs if the response to the combined chemicals differs from the effects of any ingredient individually, resulting in a different mode of action. The toxicity of mixed ingredients may also be decreased when combined. For example, antagonistic effects occur when combined materials reduce the effect of one or more component, and varying levels of deactivation can occur before a mixture is applied.

Wildlife Protection

The Federal Endangered Species Act (ESA) and the California Endangered Species Act (CESA) makes it unlawful to harm any plant or animal listed by the Fish and Wildlife Service (FWS) as endangered or threatened. The EPA, in cooperation with the USDA and the FWS, developed an Endangered Species Protection Program to protect listed species from harmful effects of pesticides. Under the program, pesticide use can be restricted in areas where endangered species are likely to be exposed.

For example, protection was added in 2006 for California Red-legged Frog (CRLF). Under a court injunction no use buffer zones were established around critical habitat areas for CRLF. For additional information see http://cdpr.ca.gov/docs/endspec/rl_frog/index.htm.

Water Quality Protection

The Clean Water Act protects the nation's waterways from both point and non-point pollution. The State of California and the nine Regional Water Quality Control Boards (RWQCB) have entered into a management agreement with CDPR such that the department serves as the lead agency for pesticide regulation and will take into account water quality information provided by the regional boards. If a water quality problem arises, the agreement defines the process for RWQCBs to go through the CDPR to provide additional protection. The regional boards could also amend the basin plan and require monitoring. Under the Porter-Cologne Water Quality Control Act, the boards can require reporting of waste discharge.

According to the Ninth Circuit Court of Appeals, the application of pesticides over or onto waters of the United States, or onto aquatic plants growing in waters of the United States, is considered a direct discharge of pollutants and requires coverage under a National Pollutant Discharge Elimination System (NPDES) permit. See the RWQCBs web site for additional information on NPDES permits (http://www.waterboards.ca.gov/npdes/aquatic.html).

Air Quality Protection

Pesticides are one of many sources Volatile Organic Carbons (VOCs) that can contribute to the formation of ozone in the lower atmosphere. The Clean Air Act requires states to meet national standards for airborne pollutants such as ozone. Many regions in California do not meet air quality standards and are considered non-attainment areas. CDPR works with the Air Resources Board to develop and implement strategies to reduce pesticides as source of VOCs, which contribute to smog (CDPR, 2001).

4.17.3 Forest and Rangeland Herbicide Use

Forestry and Timberland Management

Herbicide technology has steadily evolved over the last 60 years and is an integral part of modern forestry practices, particularly where successful commercial timber species regeneration and enhanced yields are sought. The list of herbicide options for forest managers has increased slowly with the addition of several new chemicals and an increase in the spectrum of plant species controlled. Along with changes in herbicide development and technology there has been a corresponding change in the management context of herbicide use in forestry. More recently, the development of integrated pest management concepts and increased emphasis on ecological and social concerns in forest management have further broadened the view of vegetation management concept in forestry (Wagner et al., 2004).

Herbicides are used on timberlands to control competing and undesirable plant species and to allow commercially valuable species the opportunity to maximize growth. Foresters seek two types of herbicidal activity. Pre-emergent herbicides inhibit seed germination or reduce seedling survival. They are used to prevent weed species from becoming established and are applied to infiltrate the soil and remain active in the shallow root zone. Post-emergent herbicides kill established plants through translocation, so that a sufficient dose applied to a part of the plant will kill, or inhibit growth in the entire plant. Thus post-emergents are applied to the foliage, to the basal stem, to frill cuts on the stem of larger hardwood (“hack and squirt”), or to the stump of cut vegetation to kill the root and prevent sprouting. Aerial herbicide application is sometimes used where broadcast treatment is required to control competition from brush and undesirable species over large areas. For vegetation control following tree removal it is common for both a soil active pre-emergent herbicide and a foliar post-emergent herbicide to be mixed and applied at the same time. The post-emergent kills established weeds, and the pre-emergent has residual activity throughout the rest of the growing season. When working where conifer sprouts or seedlings are present, the application is done by hand with a backpack sprayer used to target weeds and avoid young trees. Where brush and non-commercial hardwoods such as tan oak and madrone have become established, reconversion to conifers requires a different technique. Small shrubs can have a post-emergent herbicide applied to the basal bark, while larger trees are frilled or cut and stump treated.

Range Management

Rangelands cover approximately 50 million acres in California (CAL FIRE, 2003). Rangeland includes land in which the native vegetation is predominantly native grasses, grass-like plants, forbs, or shrubs. This incorporates a variety of landscapes including grasslands, savannas, shrub lands, and some desert environments. The use of herbicides is undertaken as part of a weed management strategy to eliminate invasive or non-desirable forage plants. A key objective in weed management is to maintain the productivity of rangelands while minimizing the impact and occurrence of weeds. For weed management on rangelands only a small number of commercially available herbicides are commonly used (see Table 4.17.9).

Wildlife Habitat Management

All of the tools currently available to managers of plant community succession have the potential to improve or degrade wildlife habitat quality depending on the objectives, extent, and intensity of application. Herbicides can be an efficient and cost effective tool for the manipulation of wildlife habitats (Miller and Miller, 2004). Modern silvicultural herbicides are designed to target biochemical processes unique to plants and exhibit a low level of toxicity to animals (Tatum, 2004). Manual spot application and stem injection can accurately control herbicide placement and amount with little risk of non-target effects (Shepard et al., 2004).

Native plant community restoration efforts as a result of exotic and invasive species expansion are another avenue for herbicide application. Herbicide use in conjunction with other control mechanisms (manual or biological, as appropriate) are valuable tools for the control of exotic species; a use recognized by leading conservation organizations such as The Nature Conservancy and the Audubon Society (Williams, 1997).

Herbicides Used

The following section provides a description of the most commonly used herbicides for use in forestry and rangeland management. Table 4.17.9 provides a list of the most common commercially available herbicides (active ingredient and adjuvant) for both forest and range lands.

GLYPHOSATE

Glyphosate is a non-selective post-emergent herbicide used in the control of grasses, weeds, and brush. It is usually applied to foliage, but may also be used on freshly cut stumps for brush control. There are now other glyphosate formulations registered for use in California including labels for aquatic use and formulations with different adjuvants. Glyphosate is used to control grasses, herbaceous plants including deep-rooted perennial weeds, brush, and some broadleaf trees and shrubs. Timing of application is critical for effectiveness on some broadleaf woody plants and conifers. It is applied to foliage and rapidly moves through the plant phloem. It acts by preventing the plant from producing an essential amino acid. It also may be used as a cut stump, injection, or frill application directed to the cambium. The two most widely used formulations are Roundup® (41% isopropylamine salt of glyphosate and inert ingredients) and Rodeo® (53% isopropylamine salt of glyphosate and inert ingredients).

TRICLOPYR

Triclopyr has activity as a synthetic auxin, a mimic of a naturally occurring plant hormone, and is used to control perennial broadleaf weeds and brush. Depending on the form of the active ingredient, triclopyr is formulated as either triethylamine salt (e.g. Garlon 3A®) or as a butoxyethyl ester (e.g. Garlon 4®) Triclopyr is a selective herbicide that is absorbed by foliage and roots and then spreads throughout the plant. It is used to control woody plants and broadleaf weeds on rights-of-way, non-crop areas, forests, wildlife openings, and other areas. Triclopyr has little effect on grasses. Triclopyr is applied by ground or aerial foliage spray, basal bark and stem treatment, cut surface treatment, and tree injection.

2,4-D (2,4-DICHLOROPHENOXYACETIC ACID)

2,4-D is a systemic herbicide with auxin like activity used to control many types of broadleaf vegetation. It is widely used in the United States for the control of woody species such as willow, alder, sumac, and sagebrush. In forestry, herbicide formulations containing 2,4-D are commonly used in wildlife openings, rights-of-way maintenance, and noxious weed control (U.S. Forest Service, 2006). Many different formulations, including esters, amines, and salts of the primary acid, are prepared for use in the field and sold by several manufacturers. In general herbicides formulated with 2,4-D esters have higher concentrations of 2,4-D than do herbicides formulated with 2,4-D salts (U.S. Forest Service, 2006). Variations in these formulations affect toxicity, mobility, volatility, and persistence to some degree. More than one form is used for rangeland and forests (2-ethylhexyl ester, butoxyethanol ester, dimethylamine salt, and isooctyl ester).

ATRAZINE

The use of atrazine is not anticipated as part of the VTP, but its effects are discussed here because it has been used on forest lands in California.

Atrazine is one of the most commonly used herbicides in the United States. It is used as a pre-emergent herbicide primarily in agricultural crops and non-selectively on rights-of-way, forest and range land sites. Atrazine is applied to the soil or to run off onto the soil. Often used under the formulation name AAtrex 4L, and AAtrex Nine-O, in forestry it has the effect of a short-duration pre-emergent herbicide and is also tank mixed with Garlon or Roundup.

SULFOMETURON METHYL

Often formulated as Oust® XP, sulfometuron methyl is used on non-crop areas for nonselective weed control as a broad spectrum pre- and post-emergent herbicide (Table 4.17.1). The herbicide is used for general weed control on forest lands. Pre-emergence treatments control or suppress weeds through root uptake, and post-emergence treatments control via root and foliar uptake. Sulfometuron methyl acts to suppress amino acid synthesis in plants by inhibiting the plant enzyme acetolactate synthase, particularly in growing tips, roots, and shoots. It is applied to the soil at extremely low rates and has moderate to long persistence. Sulfonylureas are potent herbicides; thus, they are used at much lower rates than other herbicides.

Table 4.17.1
Herbicide Products Names that Contain Sulfometuron-Methyl and have been documented by Dept. of Pesticide Regulation as being used on Forest Lands in California

E.I. Du Pont De Nemours & Co.	Sulfometuron-Methyl	F	Du Pont Oust XP Herbicide (352- 601-AA)
E.I. Du Pont De Nemours & Co.	Sulfometuron-Methyl	F	Dupont Westar Herbicide (52- 626-AA)
Riverdale Chemical Company	Sulfometuron-Methyl	F	Riverdale Spyder Herbicide (228- 408-Aa)

HEXAZINONE

Hexazinone is an herbicide that is used to control grasses and broadleaf plants and many shrub species. It is generally applied in late summer or fall. The granules dissolve following rainfall and the active ingredient moves into the root zone. Hexazinone is used to release conifers from competing vegetation and non-selectively for the control of weeds and woody plants. Because it can be applied directly in granular form, it is more economical than some alternatives. The most commonly used forest management formulation is Velpar®. Velpar may be used as either a pre- or post-emergent foliar spray during active plant growth. Because redwood is particularly sensitive to hexazinone, it is not usually used in the coastal part of Humboldt County (Paul Holzberger, Humboldt County Agriculture Department, Personal communication, September 18, 1998).

IMAZAPYR

Imazapyr, isopropylamine salt, can be applied to establish and maintain wildlife openings, to prepare sites for reforestation, and to release conifers from competing vegetation (SERA, 2004). It also provides control of many annual and perennial weeds including grasses, broadleaf plants, vines, brambles, brush, and trees. Two commercial formulations are often used in forest management, Arsenal and Chopper. Arsenal is most commonly used for industrial and rights-of-way use and other forest management practices. Chopper is used for cut stump, basal bark, and frilling use. Imazapyr's mode of action inhibits acetolactate synthase. Plant death results from disruption of biosynthesis of branch chained amino acids (Kamrin, 1997). The compound may be used as either a pre- or post-emergent. Post-emergent use is preferred for the control of perennial species. For maximum herbicidal activity, weeds should be growing at the time of application. Depending on the species, the rate of application ranges from 2 to 6 pints/acre. Arsenal is mixed with water; Chopper is mixed with diesel fuel or water.

Table 4.17.2
Herbicide Products Names that contain Imazapyr-Isopropylamine Salt and have been documented by Department of Pesticide Regulation as being used on Forest Lands in California.

BASF Corporation	IMAZAPYR, ISOPROPYLAMINE SALT	F	ARSENAL HERBICIDE APPLICATORS CONCENTRATE (241- 299-ZA)
BASF Corporation	IMAZAPYR, ISOPROPYLAMINE SALT	F	CHOPPER HERBICIDE (241- 296-ZB)
BASF Corporation	IMAZAPYR, ISOPROPYLAMINE SALT	F	STALKER HERBICIDE (241- 398-ZA)
Riverdale Chemical Company	IMAZAPYR, ISOPROPYLAMINE SALT	F	POLARIS AC HERBICIDE (241- 299-AA- 228)
Riverdale Chemical Company	IMAZAPYR, ISOPROPYLAMINE SALT	F	POLARIS SP HERBICIDE (241- 296-AA- 228)

CLOPYRALID

Clopyralid, monoethanolamine salt is commonly used as Transline®, primarily for control of star thistle in wildland settings in California. Application is typically by hand, but it is registered for aerial application as well. It is licensed in California for control of thistles on forested sites and for selective control of weeds and woody plants on rangeland, non-cropland areas, rights-of-way, and other sites. Clopyralid is absorbed by the leaves and indirectly via the roots of the weed and moves rapidly through the plant. It affects plant cell respiration and growth. It has little effect on grasses, members of the mustard family (Brassicaceae), and several other groups of broad-leaved plants. Clopyralid controls many annual and perennial broadleaf weeds, particularly those of the plant families Asteraceae (Aster), Fabaceae (Pea), Solanaceae (Nightshade), Polygonaceae (Buckwheat), and Violaceae (Violet).

Fungicides Used

BORAX

Borax is a fungicide applied directly to tree stumps to prevent heterobasidion root disease. The treatment of stumps with borax is to prevent fungus spores from gaining entrance into the stump. The application rate on private forest lands is not well documented, but application rates on USFS lands range from 0.1 lb/acre to 1.87 lb/acre. The following descriptions of the environmental fate and potential effects on human and wildlife are largely based upon risk characterization studies conducted by the USFS (SERA, 2006).

4.17.4 Prevalent Public Issues Relating to Herbicide Application

Public concern about the toxicity of herbicides and other chemicals potentially used in forest and range land applications centers on the effects on non-target organisms (Guynn et al., 2004; Tatum, 2004). Non-target toxicity is evaluated and regulated by the U.S. EPA under the Federal

Insecticide Fungicide and Rodenticide Act (FIFRA). Prior to herbicides being licensed for sale and use, information is gathered regarding toxicity to animals and non-target plants, herbicide mobility and dissipation in soils and in water, and residues in soils, food crops, and livestock (Shepard et al., 2004). "Literature reviews on the direct, acute effects of herbicides on wildlife have concluded that at recommended rates and normal use scenarios, herbicides used in forest management operations pose little if any acute toxicity hazard to wildlife, are not mutagenic or oncogenic, and are rapidly eliminated from animal systems once ingested/absorbed." (Shepard et al., 2004). The following are public issues of concern:

- Pesticides in Surface Water or Groundwater: The U.S. Geological Survey (USGS) monitors pesticides in groundwater and surface water as part of the National Water Quality Assessment Program. Although surveys conducted by USGS found that trace levels of agricultural pesticides were commonly found in ground and surface water samples, concentrations rarely were in excess of standards for drinking-water (U.S. Geological Survey, 1999). Few forest herbicides have been found in these surveys (Shepard et al., 2004).
- Herbicide Testing Methods: The public and some members of the scientific community have criticized the herbicide testing methods conducted under FIFRA. Principally, concerns center on the applicability of test results from the reaction of a single or small group of species to that of complex ecosystems, the effect of adjuvants or ingredients designated as "inert" primarily because these chemicals are not active towards the target pest, the greater than additive toxicity when two or more herbicides are mixed prior to application (Shepard et al., 2004), or the potential for herbicides to act as endocrine disrupters.
- Environmental Effects of Surfactants: In 1987, the U.S. EPA instituted a policy requiring herbicide manufacturers to consider the long-term health and environmental effects of inert ingredients. Surfactants (adjuvants that act as surface active agents, increasing absorption into or sticking on to target surfaces) can have varying levels of toxicity and usually are not included in FIFRA testing.
- Synergistic Effects of Herbicide Mixtures: Herbicides used in forest vegetation management are often applied in a mixture of two or more herbicides and associated adjuvants. Synergistic toxicity (toxicity is greater than the sum of the parts) is the most difficult to assess given the multiple pathways by which synergism may occur (Tatum, 2004). Herbicide mixtures that include surfactants or other adjuvants are not tested as part of the FIFRA evaluation process. These mixtures could result in synergistic toxicity (toxicity of the mixture is greater than the sum of its parts). Synergistic toxicity has been found at low levels for a 50:50 mixture of atrazine and alachor to American toads (*Bufo americanus*) but the occurrence is rare (Howe et al., 1998 fide Shepard et al., 2004). Mixtures of these herbicides on benthic and algal communities produced an additive effect and not a synergistic one (Carder and Hoagland, 1998 fide Shepard et al., 2004).
- Toxicity of Surfactants: Public concern has arisen over the toxicity of surfactants compared to the active ingredient used in herbicide mixes. A major qualitative difference between the effect of glyphosate and glyphosate formulations on aquatic and terrestrial organisms concerns a polyethoxylated tallow amine surfactant (POEA) that is commonly used in

Roundup. For aquatic organisms, the surfactant is much more toxic than glyphosate. Unlike glyphosate, POEA is more toxic in alkaline water than in acid water. Thus, the relative potency of POEA with respect to glyphosate is pH dependent. There is relatively little information regarding Roundup Pro, a formulation of glyphosate that contains a phosphate ester neutralized polyethoxylated tallow amine surfactant. Nonetheless, the available data suggest that this formulation is quite similar to Roundup. There is an extensive amount of literature on glyphosate specifically (Boerboom and Wyse, 1988; SERA, 1997; Cranmer and Linscott, 1991; Sherrick et al., 1986) and many other compounds (Green et al., 1992) indicating that the addition of surfactants can greatly enhance the phytotoxicity of herbicides (SERA, 1997).

- Drift and Environmental Contaminants: Recent research has raised concerns that pesticide use in the Central Valley can drift into the mountains and over time concentrations accumulate in mountain lakes and subsequently in the tissues of amphibians. It further suggested that these atmospheric inputs from agricultural areas are at least partially responsible for declining amphibian population in the Sierra (Fellers et al., 2004).
- Impacts to Aquatic Habitat, Wildlife Habitat and Biodiversity: The use of herbicides along with other vegetation management treatments have the potential to enhance or degrade wildlife habitat depending on the management objectives. Miller and Miller (2004) reviewed studies in southern United States and found most impacts to habitat and biodiversity were temporary.

4.17.5 Adjuvants, Diluents, Marker Dyes, and Other Colorants

The following discussion is excerpt from an USDA report on Mark Dyes (SERA, 1997). The entire report is available on-line at:
http://www.fs.fed.us/foresthealth/pesticide/pdfs/091602_markerdyes.pdf

> *The use of any agent—herbicides, dyes, surfactants, or other additives—may pose some level of human risk. The use of dyes may also have beneficial consequences. For example, dyes will discolor the treated vegetation, making it less likely that an individual will inadvertently or intentionally consume contaminated vegetation. Moreover, the use of dyes in a herbicide formulation could assist workers in limiting their exposure to the dye/herbicide formulation. In other words, the presence of a dye in the applied formulation will make it easier for workers and supervisors to recognize when exposure has occurred, which, in turn, could facilitate prompt remedial action.*
>
> *Not withstanding these potential benefits, the colorants or other components in the dyes may pose additional risks to humans and wildlife. The assessment of these risks is severely limited by the proprietary nature of dye formulations. For most of the available dyes, neither the colorants nor adjuvants in the dye formulation are disclosed by the manufacturers. As reviewed by Levine (1996), this problem is general to the assessment of risks posed by all inerts in pesticide formulations. Unless the compound is classified as hazardous by the U.S. EPA, the manufacturer is not required to disclose its identity. This policy would not seriously impede the process of risk assessment if the regulation and classification of inerts involved rigorous testing comparable to those associated with active ingredients. That, however, is*

not the case. As discussed by Levine (1996), the U.S. EPA is increasing the testing requirements on new inerts; however, many of the inerts currently in use were not tested rigorously and their toxicity is not well characterized. Thus, when a colorant or other adjuvant in a dye formulation is not listed as hazardous and therefore not identified on the product label or MSDS it should not be concluded that the dye or adjuvant is not toxic.

ADJUVANTS

Applicators may add adjuvants to the formulation as supplied by the manufacturer. Generically these additives help keep the herbicide on the target, improve wetting and tissue penetration. They range from conventional surfactants to petroleum products, glycols, and alcohols, to the more recent silicone and oils. In California, adjuvants are also subject to registration, and label language must be followed. Surfactants are a type of adjuvant that are used to help bind the herbicide to the targeted vegetation primarily by breaking the natural surface tension of water-based formulas. Potential toxicity from surfactants is becoming an issue of public concern, because surfactants are not subject to the same testing requirements as active ingredients. Some studies have suggested that surfactants can be more acutely toxic than active ingredient in the herbicide (Tatum, 2004; Haller and Stocker, 2003). Some surfactants, such as POEA (Polyethoxethyleneamine), are considered water soluble and public concern has been raised about potential toxic effects.

DILUENTS

As supplied by the manufacturer, the herbicide's active ingredient is in a concentrated form and is usually diluted for application. The exception is some frill and cut stump treatments where undiluted herbicide is applied directly to the cut surface of the stump. The most common diluent is water, which serves for both water-soluble and poorly soluble herbicides. Poorly soluble herbicides are dispersed in water with a surfactant usually provided in the commercial stock solution. For basal bark treatment, the oil-soluble herbicides such as triclopyr or 2,4-D will be mixed with an oil, commonly vegetable based, which helps the herbicide adhere to and penetrate the bark.

4.17.6 Forestry and Rangeland Herbicides in Native Plants - Drift

Native Americans utilize native plants for food, medicine, basket weaving, and other traditional uses. Community groups and some members of the general public may utilize native plants for similar purpose. Herbicide exposure may occur, predominately on public lands, when gathering plants in or adjacent to treatment areas. The Department of Pesticide Regulation (CDPR) conducted a forest herbicide study to determine the dissipation rates and the drift associated with herbicide use on National Forest lands. Four plants commonly used by Native Americans were used to examine the longevity of herbicide use: buckbrush shoots, golden fleece foliage, bracken roots, and Manzanita berries. As expected there was a declining trend in amount of herbicide in plant material over time. For the most part herbicides were not detectable or plant material was no longer available after 80 weeks (CDPR, 2002). There was minimal detection of off-site movement of herbicides and most residues were detected within 70 feet from the edge of the treatment area (Ando et al., 2002).

4.17.7 Current Forestry and Rangeland Vegetation Management Herbicide Use

Current herbicide use patterns represent the environmental baseline for the proposed project. The following section discusses the extent of herbicide use statewide, by bioregion and provides countywide reports in tables at the end of this section. The information presented in this section can be obtained through the CDPR web site: http://www.cdpr.ca.gov/docs/pur/purmain.htm. The USFS also provides summaries of pesticide use on National Forest lands (http://www.fs.fed.us/r5/spf/publications/ pesticide), although that use is also contained within state reports.

The amount of herbicide use reported in the following tables and appendices includes both the pounds of product applied and the amount of active ingredients (a.i.) used. The a.i. represents the portion of the herbicide that is being applied to vegetation to remove weeds or undesired vegetation.

Commercial pesticide use in California has been estimated by CDPR at 173 million pounds in 2010. Agriculture accounts for the predominant use of pesticides, but pesticides are also applied to forest and range lands and other areas requiring vegetation management (Figure 4.17.1). Overall pesticide use varies from year to year; the amount is influenced by current pest problems, weather, types of crops grown, and what new chemicals become available (CDPR, 1997). The use of pesticides is broad based, but the most intensive application of pesticides for agricultural crops is in California's Great Central Valley, the Salinas Valley, and the agricultural lands surrounding the Salton Sea.

In 2010, forestry (private and public lands) accounted for 327,336 pounds of herbicide products applied (157,501 pounds active ingredient) on 122,509 acres of forest land. Application of pesticides on forest lands represents less than 1% of the estimated 173 million pounds that were applied statewide in 2010. The known herbicides that were reportedly used on forests in 2010 are listed in Table 4.17.3. The most commonly used herbicides include: Glyphosate (49%), Hexazinone (28%), and Imazapyr (13%).

A total of 29,445 pounds of herbicides (10,905 pounds active ingredient) were applied to 32,012 acres of rangelands in 2010 (CDPR, 2008). Reported herbicide use is shown in Table 4.17.4. The most common herbicides used on rangelands includes: 2, 4-D Dimethylamine Salt (41%), Glyphosate (35%), and Triclopyr (9%). There is some year to year variation is herbicide use as shown in Table 4.17.5., but no discernable trend.

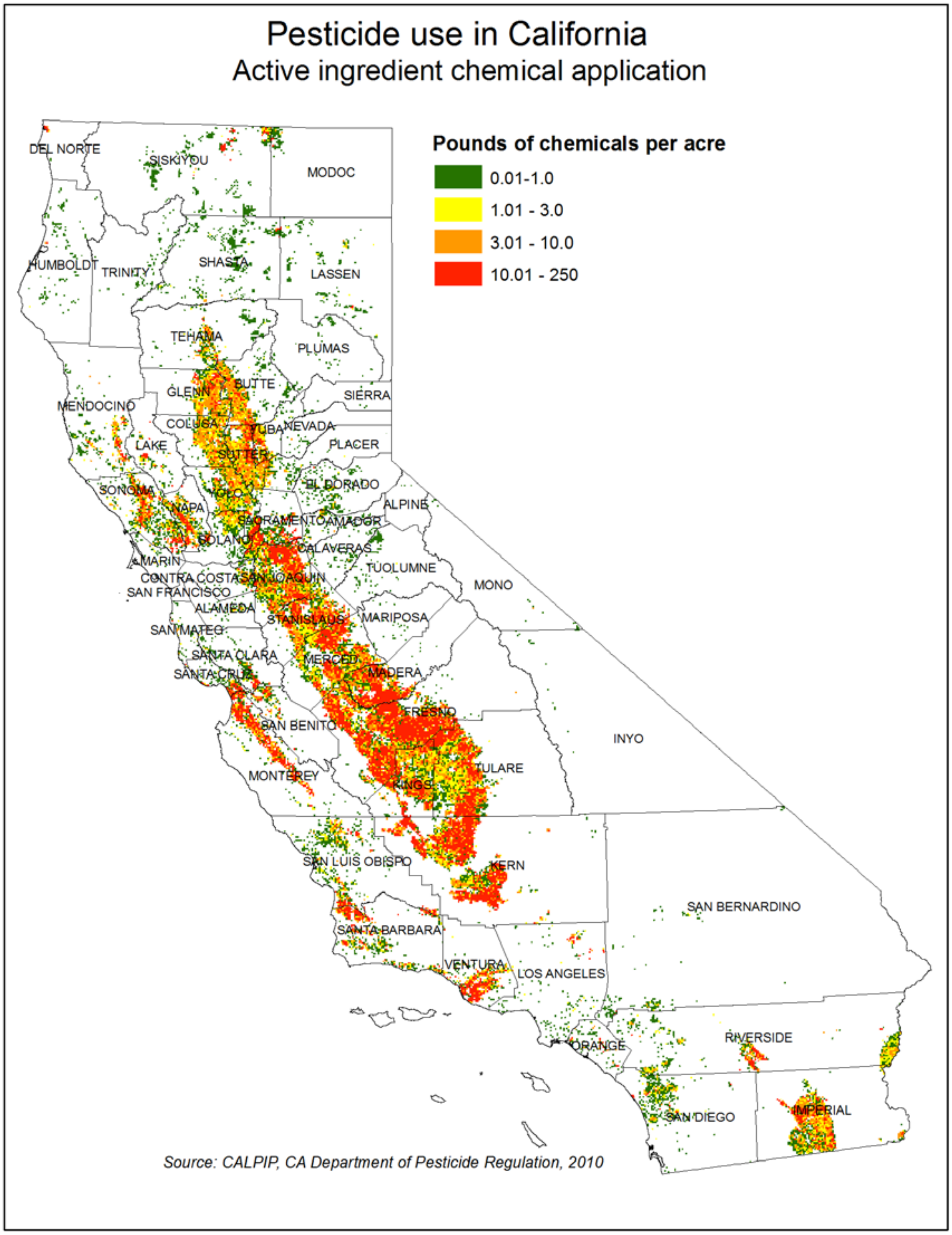

Figure 4.17.1 Pesticide Use in California for all Land Uses (2010)

Table 4.17.3
Forestry Herbicides (Active Ingredient and Adjuvants – 2010)

Chemical Name	AI lbs Applied	Lbs Product Used	Acres Treated
2,4-D, 2-ETHYLHEXYL ESTER	485	730	1,617
2,4-D, ISOOCTYL ESTER	3,015	3,460	2,133
ALPHA-UNDECYL-OMEGA-HYDROXYPOLY(OXYETHYLENE)	365	2,433	651
AMINOPYRALID, TRIISOPROPANOLAMINE SALT	1	2	5
ATRAZINE	720	1,650	215
BACILLUS PUMILUS, STRAIN QST 2808	3	217	25
BORAX (fungicide)	4,061	4,059	8,870
CLOPYRALID, MONOETHANOLAMINE SALT	173	419	731
FLUROXYPYR, 1-METHYLHEPTYL ESTER	26	57	163
GLYPHOSATE, DIMETHYLAMINE SALT	4,196	8,381	3,806
GLYPHOSATE, ISOPROPYLAMINE SALT	72,815	172,683	39,867
GLYPHOSATE, POTASSIUM SALT	10	19	25
HEXAZINONE	44,177	61,853	17,148
IMAZAPYR, ISOPROPYLAMINE SALT	21,233	59,566	39,495
METHYLATED SOYBEAN OIL	1,702	2,433	651
ORYZALIN	4	10	2
SULFOMETURON-METHYL	12	17	209
TALL OIL FATTY ACIDS	365	2,433	651
TRICLOPYR, BUTOXYETHYL ESTER	3,816	6,189	5,113
TRICLOPYR, TRIETHYLAMINE SALT	322	725	1,132
TOTAL	**157,501**	**327,336**	**122,509**

Table 4.17.4
Range Herbicides (Active Ingredient and Adjuvants) Used During 2010

Chemical Name	AI lbs Applied	Lbs Product Used	Acres Treated
2,4-D, 2-ETHYLHEXYL ESTER	14	22	27
2,4-D, BUTOXYETHANOL ESTER	6	21	4
2,4-D, DIMETHYLAMINE SALT	4,426	9,457	4,927
2,4-D, ISOOCTYL ESTER	52	60	52
AMINOPYRALID, TRIISOPROPANOLAMINE SALT	735	5,052	8,342
BROMACIL	8	20	10
CARFENTRAZONE-ETHYL	5	20	1,450
CHLORSULFURON	31	40	679
CLOPYRALID, MONOETHANOLAMINE SALT	563	1,388	7,628
DICAMBA, DIMETHYLAMINE SALT	7	15	36
DIMETHYLPOLYSILOXANE	46	45	192
DIURON	16	40	14
FLUMIOXAZIN	1	2	9
GLUFOSINATE-AMMONIUM	6	33	6
GLYPHOSATE, DIAMMONIUM SALT	6	30	6
GLYPHOSATE, ISOPROPYLAMINE SALT	3,748	8,447	3,381
GLYPHOSATE, POTASSIUM SALT	148	323	118
IMAZAPYR, ISOPROPYLAMINE SALT	10	37	49
ORYZALIN	4	10	2
OXYFLUORFEN	21	93	98
SIMAZINE	2	2	2
TRICLOPYR, BUTOXYETHYL ESTER	467	804	3,949
TRICLOPYR, TRIETHYLAMINE SALT	583	3,484	1,031
Grand Total	**10,905**	**29,445**	**32,012**

Table 4.17.5
Trends in Pesticide Use from 2000-2010
modified from CAL FIRE (2010; CA Dept. of Pesticide Regulation
http://www.cdpr.ca.gov/docs/pur/purmain.htm)Lbs Applied
note: includes herbicides, insecticides, and fungicides.

Year	*Forestry*	*Rangeland*	*Total Statewide*
2010	280,089	13,885	173,213,823
2009	186,205	11,902	158,168,838
2008	236,345	21,937	161,531,155
2007	234,833	19,476	171,879,918
2006	258,799	12,286	187,867,887
2005	213,752	21,911	195,263,057
2004	218,052	24,837	180,272,161
2003	229,134	24,543	175,127,171
2002	264,539	22,625	172,086,290
2001	213,981	16,351	151,124,888*
2000	152,974	19,673	187,566,930

4.17.8 Bioregion Summary

Data on pesticide use from was further summarized using county-based bioregions for the entire state (Table 4.17.6; Figure 4.17.2). The more detailed county-based reports are provided in Tables 4.17.10 and 4.17.11 and list the herbicides that were used on forest and rangeland.

The Sacramento Valley Bioregion had the highest concentration of herbicide use among all bioregions. Herbicide use on forest lands was concentrated mainly in the North Coast, Sierra, Modoc and Sacramento Valley Bioregions. These bioregions collectively accounted for 97% of all herbicide use on forest lands. On rangelands pesticide use occurred predominately in the Bay Delta, San Joaquin Valley, and Central Coast bioregions. Collectively these bioregions accounted for 84% of the total pesticide applied to rangelands statewide.

At the county level, the majority of the pesticide use on forest lands occurs in just a few counties. Shasta, Siskiyou, Lassen, Trinity, Tehama, Butte and El Dorado counties collectively account for 72% of the pesticide use on private forest lands in 2010. On rangelands pesticide use was most concentrated in the following counties: Sonoma, San Luis Obispo, Merced Tulare, Santa Barbara, Solano, Fresno and Tulare. Collectively, these counties accounted for 80% of the pesticide use on rangelands in 2010.

Table 4.17.6
Summary of Herbicide Use on Forest and Rangelands for 2010

BIOREGION	FOREST LBS USED	FOREST ACRES TREATED	RANGELAND LBS USED	RANGELAND ACRES TREATED	REGION TOTAL LBS USED	REGION TOTAL ACRES TREATED
BAY DELTA	76	143	2,706	13,950	2,782	14,093
CENTRAL COAST			2,582	5,289	2,581	5,289
COLORADO DESERT					0	0
MODOC	22,043	11,858	26		22,043	11,858
MOJAVE			41	116	41	116
NORTH COAST	31,284	64,243	110	299	31,395	64,542
SACRAMENTO VALLEY	63,909	103,227	720	1,713	64,629	104,940
SAN JOAQUIN VALLEY	786	1127	3,802	9,925	4,728	11,052
SIERRA	40,592	59,613	799	4,160	41,249	63,773
SOUTH COAST	0		284	142	284	142
Grand Total	**158,690**	**240,211**	**11,044**	**35,594**	**169,732**	**275,805**

Figure 4.17.2 County based bioregions for California

4.17.9 Herbicide Use on Federal Forest and Range Lands

The United States Department of Agriculture (USDA) Forest Service annually reports data on pesticide and herbicide use on national forests and range lands. In California, for 2008 the Forest Service reported that herbicides totaling 9,519 lbs of herbicides and fungicides were applied on 17,186 acres of National forestland. Borax and Glyphosate were the most commonly used treatments. The most common herbicide treatment on national forests in California in 2008 was for disease control, maintenance of fuel breaks, Nursery operations, and invasive species treatments. Tables 4.17.7a and 4.17.7b summarize by Bioregion the type and amount of herbicides that were applied on each of the national forests within California. Note the following forests reported herbicide use in 2008: North Coast Bioregion (Six Rivers, Klamath, Mendocino and Shasta-Trinity); Modoc Bioregion (Lassen); Central Coast Bioregion (Los Padres); South Coast (Angeles, San Bernardino); Sierra Bioregion (Inyo, Tahoe, Sierra, and Eldorado). In addition, herbicide use on USFS lands is reported annually to Department of Pesticide Regulation and that information is included in estimating statewide totals shown in Tables 4.17.4, 4.17.5, 4.17.10 and 4.17.11.

Table 4.17.7a
Amount of Herbicide Use on USFS Lands Summarized by Bioregion for 2008 (units are in pounds [lbs.])
Note that the data was compiled for individual forests and then aggregated into Bioregions.

	Central Coast	Modoc	North Coast	Sierra	South Coast	Grand Total	
aminopyralid			0.6			0.6	0.01%
borax		628	3812	643	3528	8,611	90.46%
chlorsulfuron		0.07	0.08			0.15	0.00%
clopyralid				62.72		62.72	0.66%
glyphosate	4		414.4	277.9	4.6	700.9	7.36%
oxyfluorfen			88	1		89	0.93%
triclopyr				0.5	1.5	2	0.02%
Grand Total	**4**	**662.07**	**4,332.88**	**985.50**	**3,534.5**	**9,518.95**	**100.00%**

Table 4.17.7b
Amount Area Treated with Herbicides on USFS Lands Summarized by Bioregion for 2008 (units are in acres)
Note that the data was compiled for individual forests and then aggregated into Bioregions.

Common Name	Central Coast	Modoc	North Coast	Sierra	South Coast	Grand Total
aminopyralid			7			7
borax		749	6,162	821	6,088	13,820
chlorsulfuron		1	7			8
clopyralid				252		252
glyphosate	5		250	355	192	802
oxyfluorfen			44	6		50
triclopyr				14	0.3	14.3
Grand Total	**5**	**770**	**6,548.1**	**1,583.3**	**8280.3**	**17,186.7**

The Bureau of Land Management also uses herbicide for vegetation management on public lands in California. Table 4.17.8 provides a summary of BLM herbicide use in California. Between 2006 and 2008 BLM treated an average of 2,447 acres annually using an average 1,695 pounds of herbicides. Most herbicide use involved ground applications, but there are some aerial applications using either Clopyralid or 2, 4-D, and Chlorsulfuron.

Table 4.17.8
Amount of Herbicides Applied on BLM Lands from 2006-2008 (in pounds)

	2006 Data				2007 Data				2008 Data			
Herbicide	Ground Application		Aerial Application		Ground Application		Aerial Application		Ground Application		Aerial Application	
Active Ingredient	Acres	Lbs. AI/AE	Acres	Lbs. AI/AE	Acres	Lbs. AI/AE	Acres	Lbs. AI/AE	Acres	Lbs. AI/AE	Acres	Lbs. AI/AE
Chlorsulfuron	721.1	31.7			753.3	63.0	2.5	0.1	55.5	4.1		
Clopyralid	390.8	100.0	71.5	15.6	876.5	159.3	64.5	16.1	98.7	24.4	55.0	13.8
2,4-D	828.4	510.6	71.5	70.3	584.7	462.4			49.4	30.1	27.0	25.4
Dicamba	1.6	0.1			154.0	231.0			0.5	1.0		
Glyphosate	264.2	189.3			297.2	122.2			223.6	90.8		
Imazapyr	130.0	71.0			71.1	38.3			216.5	107.4		
Triclopyr	328.1	218.8			469.6	661.6			533.9	1827.2		
Total	**2664.2**	**1121.4**	**143.0**	**85.9**	**3206.4**	**1737.7**	**67.0**	**16.2**	**1178.1**	**2084.9**	**82.0**	**39.2**

Table 4.17.9
Active Ingredients and Adjuvants Used in Forest and Rangelands in California

Forest and Range Active Ingredients Most Used 2005-2010 According to PUR	
F	GLYPHOSATE, ISOPROPYLAMINE SALT
F	HEXAZINONE
F	IMAZAPYR, ISOPROPYLAMINE SALT
F	TRICLOPYR, BUTOXYETHYL ESTER
F	2,4-D, ISOOCTYL ESTER
F	BORAX
F	2,4-D, 2-ETHYLHEXYL ESTER
F	ATRAZINE
F	ATRAZINE, OTHER RELATED
F	TRICLOPYR, TRIETHYLAMINE SALT
F	SULFOMETURON-METHYL
R	2,4-D, DIMETHYLAMINE SALT
R	GLYPHOSATE, ISOPROPYLAMINE SALT
R	CLOPYRALID, MONOETHANOLAMINE SALT
R	TRICLOPYR, BUTOXYETHYL ESTER
R	GLYPHOSATE, POTASSIUM SALT
R	GLYPHOSATE, DIAMMONIUM SALT
R	TRICLOPYR, TRIETHYLAMINE SALT
R	2,4-D, BUTOXYETHANOL ESTER
R	2,4-D, 2-ETHYLHEXYL ESTER
Forest and Rangeland Adjuvant Ingredients Most Used 2005-2000 According to PUR	
F	OLEIC ACID, METHYL ESTER
F	METHYLATED SOYBEAN OIL
F	POLYETHYLENE GLYCOL MONO(3-(TETRAMETHYL-1-(TRIMETHYLSILOXY)DISILOXANYL)PROPYL) ETHER
F	ALPHA-UNDECYL-OMEGA-HYDROXYPOLY(OXYETHYLENE)
F	UNDECYL POLYOXYETHYLENE
F	2-(3-HYDROXYPROPYL)-HEPTA-METHYL TRISILOXANE,ETHOXYLATED, ACETATE
F	HYDROTREATED PARAFFINIC SOLVENT
F	ALPHA-(PARA-NONYLPHENYL)-OMEGA-HYDROXYPOLY(OXYETHYLENE)
F	MINERAL OIL
F	TALL OIL ACIDS
R	PHOSPHATIDYLCHOLINE
R	ORCHEX 796 OIL
R	ALPHA-(PARA-NONYLPHENYL)-OMEGA-HYDROXYPOLY(OXYETHYLENE)
R	AMMONIUM SULFATE
R	ALKYLARYL POLY(OXYETHYLENE) GLYCOL
R	ALKYLARYL POLYETHYLENE GLYCOL ETHER

Table 4.17.10
Herbicide Use on Forest Lands by County (Source: CDPR, 2010)

	CHEMICAL	CHEMICAL APPLIED (LBS)	PRODUCT APPLIED (LBS)	ACRES TREATED
ALPINE		***442***	***975***	***475***
	BORAX	23	23	4
	CARBARYL	419	952	471
AMADOR		***2,678***	***11,678***	***4,631***
	GLYPHOSATE, ISOPROPYLAMINE SALT	2,355	5,750	1,095
	GLYPHOSATE, POTASSIUM SALT	10	19	25
	HEXAZINONE	177	722	285
	IMAZAPYR, ISOPROPYLAMINE SALT	129	468	160
	TRICLOPYR, BUTOXYETHYL ESTER	7	14	26
BUTTE		***9,715***	***57,808***	***16,291***
	2,4-D, ISOOCTYL ESTER	168	193	300
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	1	2	5
	GLYPHOSATE, DIMETHYLAMINE SALT	274	543	543
	GLYPHOSATE, ISOPROPYLAMINE SALT	5,625	13,645	2,481
	HEXAZINONE	1,992	2,656	692
	IMAZAPYR, ISOPROPYLAMINE SALT	1,655	6,062	3,007
CALAVERAS		***2,156***	***5,617***	***3,533***
	2,4-D, ISOOCTYL ESTER	256	295	247
	ATRAZINE	20	46	15
	ATRAZINE, OTHER RELATED	-	46	15
	GLYPHOSATE, ISOPROPYLAMINE SALT	1,649	4,011	966
	HEXAZINONE	154	614	187
	IMAZAPYR, ISOPROPYLAMINE SALT	75	253	464
	TRICLOPYR, TRIETHYLAMINE SALT	2	5	15
DEL NORTE		***163***	***745***	***146***
	ATRAZINE	157	370	54
	ATRAZINE, OTHER RELATED	3	370	54
	SULFOMETURON-METHYL	3	4	38
EL DORADO		***17,139***	***54,901***	***15,945***
	2,4-D, 2-ETHYLHEXYL ESTER	104	155	57

	2,4-D, ISOOCTYL ESTER	557	640	413
	ALPHA-UNDECYL-OMEGA-HYDROXYPOLY(OXYETHYLENE)	365	2,433	651
	GLYPHOSATE, ISOPROPYLAMINE SALT	11,054	24,293	3,234
	HEXAZINONE	1,226	1,635	409
	IMAZAPYR, ISOPROPYLAMINE SALT	33	91	176
	METHYLATED SOYBEAN OIL	1,702	2,433	651
	ORYZALIN	4	10	2
	TALL OIL FATTY ACIDS	365	2,433	651
	TRICLOPYR, BUTOXYETHYL ESTER	1,719	2,799	1,324
	TRICLOPYR, TRIETHYLAMINE SALT	8	17	9
FRESNO		***672***	***2,187***	***527***
	DIFLUBENZURON	-	0	10
	GLYPHOSATE, ISOPROPYLAMINE SALT	672	1,652	195
HUMBOLDT		***3,052***	***23,607***	***10,105***
	2,4-D, ISOOCTYL ESTER	408	469	300
	CLOPYRALID, MONOETHANOLAMINE SALT	52	126	264
	GLYPHOSATE, ISOPROPYLAMINE SALT	422	1,023	539
	IMAZAPYR, ISOPROPYLAMINE SALT	1,622	5,029	3,034
	SULFOMETURON-METHYL	9	13	171
	TRICLOPYR, BUTOXYETHYL ESTER	539	873	401
LASSEN		***22,043***	***39,195***	***11,858***
	BORAX	568	568	1,047
	CARBARYL	119	275	142
	GLYPHOSATE, ISOPROPYLAMINE SALT	5,739	12,290	1,473
	HEXAZINONE	15,532	20,704	4,862
	IMAZAPYR, ISOPROPYLAMINE SALT	84	304	153
MADERA		***114***	***271***	***100***
	GLYPHOSATE, ISOPROPYLAMINE SALT	84	204	50
	TRICLOPYR, TRIETHYLAMINE SALT	30	66	50
MARIPOSA		***59***	***134***	***70***
	ATRAZINE	34	38	10
	ATRAZINE, OTHER RELATED	1	38	10

	GLYPHOSATE, ISOPROPYLAMINE SALT	18	44	25
	TRICLOPYR, TRIETHYLAMINE SALT	6	14	25
MENDOCINO		***6,942***	***19,505***	***15,587***
	BACILLUS PUMILUS, STRAIN QST 2808	3	217	25
	GLYPHOSATE, ISOPROPYLAMINE SALT	658	1,605	1,272
	IMAZAPYR, ISOPROPYLAMINE SALT	5,879	11,158	9,032
	TRICLOPYR, BUTOXYETHYL ESTER	402	652	421
MONO		***633***	***1,475***	***831***
	CARBARYL	633	1,475	831
NEVADA		***2,140***	***6,886***	***2,340***
	GLYPHOSATE, ISOPROPYLAMINE SALT	2,140	5,221	960
PLACER		***2,737***	***4,869***	***2,352***
	BORAX	695	695	943
	ESFENVALERATE	-	1	9
	GLYPHOSATE, ISOPROPYLAMINE SALT	802	1,952	268
	HEXAZINONE	1,239	1,652	378
	TRICLOPYR, BUTOXYETHYL ESTER	1	1	10
PLUMAS		***5,771***	***21,956***	***19,169***
	2,4-D, 2-ETHYLHEXYL ESTER	51	82	1,332
	2,4-D, ISOOCTYL ESTER	16	18	37
	CLOPYRALID, MONOETHANOLAMINE SALT	7	17	43
	DISODIUM OCTABORATE TETRAHYDRATE	-	1	2
	GLYPHOSATE, ISOPROPYLAMINE SALT	3,549	8,645	6,055
	HEXAZINONE	1,941	2,589	711
	IMAZAPYR, ISOPROPYLAMINE SALT	143	510	304
	TRICLOPYR, BUTOXYETHYL ESTER	64	106	1,369
	SANTA CRUZ	2	6	36
	ALUMINUM PHOSPHIDE	-	0	18
	GLYPHOSATE, ISOPROPYLAMINE SALT	2	5	18
SHASTA		***39,197***	***198,618***	***62,200***

	(Z)-9-DODECENYL ACETATE	-	5	74
	2,4-D, 2-ETHYLHEXYL ESTER	191	285	153
	2,4-D, ISOOCTYL ESTER	391	449	143
	BORAX	454	453	1,017
	FLUROXYPYR, 1-METHYLHEPTYL ESTER	26	57	163
	GLYPHOSATE, DIMETHYLAMINE SALT	2,865	5,733	2,570
	GLYPHOSATE, ISOPROPYLAMINE SALT	16,505	39,997	7,933
	HEXAZINONE	12,208	16,275	4,397
	IMAZAPYR, ISOPROPYLAMINE SALT	6,078	17,350	11,595
	PERMETHRIN	-	5	74
	STRYCHNINE	-	40	1,258
	TRICLOPYR, BUTOXYETHYL ESTER	293	475	589
	TRICLOPYR, TRIETHYLAMINE SALT	186	423	613
SIERRA		***841***	***1,842***	***719***
	BORAX	372	372	208
	GLYPHOSATE, ISOPROPYLAMINE SALT	456	1,113	104
	IMAZAPYR, ISOPROPYLAMINE SALT	2	8	38
	TRICLOPYR, TRIETHYLAMINE SALT	11	24	57
SISKIYOU		***14,178***	***48,829***	***25,993***
	2,4-D, ISOOCTYL ESTER	754	862	563
	ATRAZINE	509	1,196	136
	ATRAZINE, OTHER RELATED	11	1,196	136
	BORAX	1,949	1,949	5,651
	ESFENVALERATE	-	2	6
	GLYPHOSATE, DIMETHYLAMINE SALT	127	253	127
	GLYPHOSATE, ISOPROPYLAMINE SALT	1,651	4,025	958
	HEXAZINONE	6,422	10,557	3,734
	IMAZAPYR, ISOPROPYLAMINE SALT	2,049	5,787	4,265
	TRICLOPYR, BUTOXYETHYL ESTER	685	1,098	754
	TRICLOPYR, TRIETHYLAMINE SALT	20	45	15
SONOMA		***76***	***143***	***76***
	IMAZAPYR, ISOPROPYLAMINE SALT	76	143	76

TEHAMA		***12,502***	***52,519***	***19,889***
	GLYPHOSATE, DIMETHYLAMINE SALT	72	143	40
	GLYPHOSATE, ISOPROPYLAMINE SALT	7,743	18,920	5,103
	HEXAZINONE	3,005	4,011	1,234
	IMAZAPYR, ISOPROPYLAMINE SALT	1,682	6,095	3,207
TRINITY		***6,950***	***32,315***	***12,411***
	CLOPYRALID, MONOETHANOLAMINE SALT	91	220	366
	GLYPHOSATE, DIMETHYLAMINE SALT	858	1,709	526
	GLYPHOSATE, ISOPROPYLAMINE SALT	4,796	11,479	3,346
	IMAZAPYR, ISOPROPYLAMINE SALT	1,188	4,369	2,549
	TRICLOPYR, TRIETHYLAMINE SALT	17	36	273
TUOLUMNE		***5,994***	***26,430***	***9,548***
	2,4-D, 2-ETHYLHEXYL ESTER	139	207	75
	GLYPHOSATE, ISOPROPYLAMINE SALT	5,289	12,891	3,222
	HEXAZINONE	258	348	201
	IMAZAPYR, ISOPROPYLAMINE SALT	230	840	791
	TRICLOPYR, BUTOXYETHYL ESTER	36	58	195
	TRICLOPYR, TRIETHYLAMINE SALT	42	95	75
YUBA		***2,495***	***13,939***	***4,846***
	2,4-D, ISOOCTYL ESTER	465	533	130
	CLOPYRALID, MONOETHANOLAMINE SALT	23	56	58
	GLYPHOSATE, ISOPROPYLAMINE SALT	1,606	3,918	573
	HEXAZINONE	23	93	58
	IMAZAPYR, ISOPROPYLAMINE SALT	308	1,099	646
	TRICLOPYR, BUTOXYETHYL ESTER	70	113	25
TOTAL		**158,691**	**626,448**	**239,679**

Table 4.17.11
Herbicide Use on Rangelands by County (Source: CDPR, 2010)

	CHEMICAL	CHEMICAL APPLIED (LBS)	PRODUCT APPLIED (LBS)	ACRES TREATED
ALAMEDA		41	29,661	15,055
	2,4-D, DIMETHYLAMINE SALT	38	81	45
	ALUMINUM PHOSPHIDE	0	***1***	***40***
	CARFENTRAZONE-ETHYL	1	6	45
ALPINE		3	***28***	***244***
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	0	2	32
	CLOPYRALID, MONOETHANOLAMINE SALT	2	5	6
	GLYPHOSATE, ISOPROPYLAMINE SALT	1	2	16
AMADOR		58	2,244	468
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	1	2	6
	CLOPYRALID, MONOETHANOLAMINE SALT	0	***1***	***5***
	GLUFOSINATE-AMMONIUM	3	15	2
	GLYPHOSATE, POTASSIUM SALT	2	5	4
	ZINC PHOSPHIDE	44	2,200	440
BUTTE		125	642	790
	2,4-D, DIMETHYLAMINE SALT	22	***45***	***14***
	DIURON	8	20	4
	GLUFOSINATE-AMMONIUM	3	18	4
	GLYPHOSATE, ISOPROPYLAMINE SALT	48	***117***	***79***
	GLYPHOSATE, POTASSIUM SALT	3	6	4
	OXYFLUORFEN	10	45	75
	TRICLOPYR, TRIETHYLAMINE SALT	21	48	75
CALAVERAS		244	2,345	10,934
	2,4-D, DIMETHYLAMINE SALT	13	28	11
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	31	78	191
	CLOPYRALID, MONOETHANOLAMINE SALT	191	465	1,768
	GLYPHOSATE, ISOPROPYLAMINE SALT	2	3	2
	GLYPHOSATE, POTASSIUM SALT	1	3	2
	TRICLOPYR, BUTOXYETHYL ESTER	6	10	102

COLUSA		10	72	274
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	10	***25***	***69***
CONTRA COSTA		102	656	3,595
	2,4-D, DIMETHYLAMINE SALT	23	45	240
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	25	63	380
	CLOPYRALID, MONOETHANOLAMINE SALT	41	101	335
	GLYPHOSATE, ISOPROPYLAMINE SALT	8	21	300
	TRICLOPYR, BUTOXYETHYL ESTER	5	9	120
EL DORADO		174	553	810
	2,4-D, DIMETHYLAMINE SALT	19	42	27
	ALUMINUM PHOSPHIDE	0	3	4
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	3	***74***	***64***
	CLOPYRALID, MONOETHANOLAMINE SALT	25	59	90
	GLYPHOSATE, ISOPROPYLAMINE SALT	15	36	14
	GLYPHOSATE, POTASSIUM SALT	21	***41***	***11***
	TRICLOPYR, BUTOXYETHYL ESTER	82	130	180
	TRICLOPYR, TRIETHYLAMINE SALT	9	64	30
FRESNO		685	2,366	3,969
	2,4-D, BUTOXYETHANOL ESTER	1	***4***	***2***
	2,4-D, DIMETHYLAMINE SALT	100	214	45
	ALUMINUM PHOSPHIDE	88	160	38
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	34	83	275
	CLOPYRALID, MONOETHANOLAMINE SALT	21	59	2,146
	GLYPHOSATE, ISOPROPYLAMINE SALT	439	1,081	625
	TRICLOPYR, BUTOXYETHYL ESTER	2	***7***	***5***
GLENN		251	816	701
	2,4-D, DIMETHYLAMINE SALT	27	58	37
	CLOPYRALID, MONOETHANOLAMINE SALT	8	20	98
	GLYPHOSATE, ISOPROPYLAMINE SALT	216	527	92

HUMBOLDT		52	***60***	***54***
	2,4-D, ISOOCTYL ESTER	52	60	52
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	0	1	2
KERN		4	10	2
	GLYPHOSATE, ISOPROPYLAMINE SALT	4	10	2
LASSEN		26	55	37
	2,4-D, DIMETHYLAMINE SALT	26	55	37
MADERA		140	296	228
	2,4-D, 2-ETHYLHEXYL ESTER	14	22	27
	2,4-D, BUTOXYETHANOL ESTER	5	17	2
	CLOPYRALID, MONOETHANOLAMINE SALT	7	***18***	***60***
	GLYPHOSATE, ISOPROPYLAMINE SALT	37	87	13
	ORYZALIN	4	10	2
	OXYFLUORFEN	2	9	2
	TRICLOPYR, BUTOXYETHYL ESTER	63	114	114
	TRICLOPYR, TRIETHYLAMINE SALT	8	19	10
MARIPOSA		38	153	220
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	4	60	76
	GLYPHOSATE, ISOPROPYLAMINE SALT	8	18	88
	TRICLOPYR, BUTOXYETHYL ESTER	19	28	36
	TRICLOPYR, TRIETHYLAMINE SALT	7	47	21
MENDOCINO		2	6	107
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	1	3	73
	CLOPYRALID, MONOETHANOLAMINE SALT	1	2	34
	ESFENVALERATE	0	***1***	***0***
MERCED		1700	4,973	5,274
	2,4-D, DIMETHYLAMINE SALT	762	1,629	668
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	36	89	240
	BROMACIL	8	20	10
	CARFENTRAZONE-ETHYL	1	***4***	***50***
	DIURON	8	20	10
	GLYPHOSATE, ISOPROPYLAMINE SALT	885	1,819	650

MONTEREY		51	114	142
	2,4-D, DIMETHYLAMINE SALT	2	5	6
	GLYPHOSATE, ISOPROPYLAMINE SALT	37	83	116
	GLYPHOSATE, POTASSIUM SALT	12	25	20
NEVADA		55	92	122
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	1	2	1
	TRICLOPYR, BUTOXYETHYL ESTER	54	89	120
ORANGE		284	***1,144***	***665***
	GLYPHOSATE, ISOPROPYLAMINE SALT	284	692	142
PLACER		3	5	12
	GLYPHOSATE, ISOPROPYLAMINE SALT	1	3	1
	TRICLOPYR, BUTOXYETHYL ESTER	2	***2***	***12***
PLUMAS		15	32	92
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	0	0	2
	CHLORSULFURON	5	6	90
	CLOPYRALID, MONOETHANOLAMINE SALT	10	26	
SACRAMENTO		20	194	815
	CLOPYRALID, MONOETHANOLAMINE SALT	20	***50***	***163***
SAN BENITO		19	80	27
	2,4-D, DIMETHYLAMINE SALT	8	19	16
	GLYPHOSATE, DIAMMONIUM SALT	6	30	6
	GLYPHOSATE, POTASSIUM SALT	5	30	6
SAN BERNARDINO		41	70	116
	IMAZAPYR, ISOPROPYLAMINE SALT	1	***4***	***7***
	TRICLOPYR, BUTOXYETHYL ESTER	40	66	109
SAN LUIS OBISPO		1,188	10,171	14,363
	2,4-D, DIMETHYLAMINE SALT	133	285	103
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	436	4,195	2,933
	CHLORSULFURON	0	0	11

	DICAMBA, DIMETHYLAMINE SALT	**2**	**5**	**2**
	GLYPHOSATE, POTASSIUM SALT	19	39	10
	TRICLOPYR, BUTOXYETHYL ESTER	59	98	40
	TRICLOPYR, TRIETHYLAMINE SALT	538	3,306	895
SANTA BARBARA		1,324	3,545	1,383
	2,4-D, DIMETHYLAMINE SALT	174	375	80
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	4	9	18
	CHLORSULFURON	4	5	80
	DIMETHYLPOLYSILOXANE	45	44	185
	GLYPHOSATE, ISOPROPYLAMINE SALT	1,034	2,458	677
	TRICLOPYR, BUTOXYETHYL ESTER	63	105	86
SANTA CLARA		7	19	1,750
	CLOPYRALID, MONOETHANOLAMINE SALT	2	7	1,730
	GLYPHOSATE, ISOPROPYLAMINE SALT	5	12	20
SHASTA		79	162	680
	2,4-D, DIMETHYLAMINE SALT	21	45	25
	CARFENTRAZONE-ETHYL	0	0	75
	CHLORSULFURON	21	28	450
	CLOPYRALID, MONOETHANOLAMINE SALT	35	85	105
	TRICLOPYR, BUTOXYETHYL ESTER	2	3	25
SISKIYOU		56	216	523
	2,4-D, DIMETHYLAMINE SALT	47	98	64
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	3	6	21
	CHLORSULFURON	1	1	18
	CLOPYRALID, MONOETHANOLAMINE SALT	0	0	1
	DICAMBA, DIMETHYLAMINE SALT	5	11	34
SOLANO		733	1,764	8,428
	2,4-D, DIMETHYLAMINE SALT	170	363	291
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	48	117	924
	CARFENTRAZONE-ETHYL	1	4	200
	DIPHACINONE	0	25	2,800
	GLYPHOSATE, ISOPROPYLAMINE SALT	507	959	323

	IMAZAPYR, ISOPROPYLAMINE SALT	0	0	2
	TRICLOPYR, BUTOXYETHYL ESTER	7	43	2,800
SONOMA		1,839	5,403	12,084
	2,4-D, DIMETHYLAMINE SALT	1,321	2,825	1,752
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	65	159	307
	CLOPYRALID, MONOETHANOLAMINE SALT	172	421	923
	DIMETHYLPOLYSILOXANE	1	1	7
	FLUMIOXAZIN	1	2	9
	GLYPHOSATE, ISOPROPYLAMINE SALT	128	308	140
	GLYPHOSATE, POTASSIUM SALT	85	174	62
	OXYFLUORFEN	1	8	7
	TRICLOPYR, BUTOXYETHYL ESTER	51	80	150
STANISLAUS		36	111	615
	2,4-D, DIMETHYLAMINE SALT	2	5	3
	ALUMINUM PHOSPHIDE	4	7	300
	CLOPYRALID, MONOETHANOLAMINE SALT	28	67	145
	GLYPHOSATE, ISOPROPYLAMINE SALT	2	4	3
TEHAMA		56	682	166
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	4	9	20
	CARBARYL	30	600	30
	GLYPHOSATE, ISOPROPYLAMINE SALT	10	23	6
	TRICLOPYR, BUTOXYETHYL ESTER	12	20	50
TULARE		1,377	2,949	4,480
	2,4-D, DIMETHYLAMINE SALT	1,352	2,885	1,200
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	23	59	2,200
	CARFENTRAZONE-ETHYL	2	5	1,080
TUOLUMNE		77	192	708
	2,4-D, DIMETHYLAMINE SALT	20	42	100
	AMINOPYRALID, TRIISOPROPANOLAMINE SALT	6	15	508
	CLOPYRALID, MONOETHANOLAMINE SALT	0	0	20

	GLYPHOSATE, ISOPROPYLAMINE SALT	42	102	40
	IMAZAPYR, ISOPROPYLAMINE SALT	9	33	40
YOLO		177	417	239
	2,4-D, DIMETHYLAMINE SALT	137	293	148
	GLYPHOSATE, ISOPROPYLAMINE SALT	32	74	27
	OXYFLUORFEN	8	31	15
YUBA		12	43	96
	2,4-D, DIMETHYLAMINE SALT	9	19	16
	GLYPHOSATE, ISOPROPYLAMINE SALT	3	7	8
Grand Total		**11,104**	**72,606**	**90,696**